4.2 Modeling of the properties of agrarian entrepreneurship entities as economic agents in market interactions

Adaptation in the meso economy is a form of reflection by network structures of the effects of the hyper-, macro- and microenvironment, which seeks to establish equilibrium in market relations. Reflection on the adaptation of the economic mechanism of the functioning of agrarian entrepreneurship entities includes a full-fledged analysis of all mechanisms of market interaction. The use of modeling tools in the study of the mechanisms of market interaction contributes to an accurate, professional and operational assessment of the situation in making managerial decisions to ensure competitive advantages and develop the adaptation of the economic mechanism of the functioning of agrarian entrepreneurship entities to the conditions of the crisis state of the socio-economic system as a whole.

Studying the features of the mechanisms of market interaction of agrarian entrepreneurship entities in the process of adaptation in market conditions, we took into account the positions of such economists as Andriichuk, V. G., Khodzitska, K. R. [195], Gubeni, Yu. E., Bitter, O. A. [196], Diuk, A. A. [197], Ivanchenko, V. O. [198], Kravchenko, S. A. [199], Lupenko, Yu. O. [200, 201], Malik, M. Y. [200], Mamchur, V. A. [200, 201, 203], Malik, L. M. [202], Shpykuliak, O. H., Alieksieieva, O. V. [204] and others. The results of scientific research confirm the need to change the attitude to the problems of the village, increase the level of competitiveness, creditworthiness of agricultural production, adapt the economic mechanism of functioning in conditions of instability. Decision-making on the formation of an adaptive economic mechanism and the development of competitiveness of agricultural enterprise entities involves the use of different methods of influencing the characteristics of assessing the processes of adaptation and the level of competitiveness to achieve the goals of the enterprise. Despite all the variety of implemented approaches and methods, there is no independent, specially created and universally recognized integrative system of methods for diagnosing adaptive processes in the studies of the mechanism of adaptation.

The purpose of this article is to determine and substantiate the properties of subjects of agrarian entrepreneurship as economic agents in the conditions of market interactions by means of modeling. The achievement of the goal was facilitated by general scientific methods: methods of empirical research (measurement, comparison, modeling), methods of theoretical research (analysis and synthesis).

Without the harmonization of state and market mechanisms for regulating the functioning of agricultural business entities, it is impossible to avoid deep crisis states. The state of the process of state and market regulation actualizes the need to diagnose the parameters of intervention, space and time. The conceptual foundations of conscious and systematic regulation imply the presence and effectiveness of a powerful diagnostic apparatus.

Modeling of competitive and cooperative interactions of subjects of agrarian entrepreneurship in the process of adaptation to market conditions implied the definition of functional dependence (the function is a component of the model of adaptation of the economic mechanism of the functioning of agrarian entrepreneurship entities), the introduction of specific data on real subjects of agrarian entrepreneurship to test the function in the system of modeling the processes of adaptation of the economic mechanism functioning, obtaining modeling results (thanks to the information system developed by us), processing the results of modeling (through the normative assessment scale developed by us, which determines the levels of adaptation).

Specifically, data entry defined a second-order dynamic system as follows:

$$\begin{cases} \frac{d\beta_1}{dt} = \gamma_1 \cdot \rho \cdot \beta_1 \cdot (d_1 - \beta_1 - \beta_2) \\ \frac{d\beta_2}{dt} = \gamma_2 \cdot \rho \cdot \beta_2 \cdot (d_2 - \beta_1 - \beta_2) \end{cases}.$$

A matrix of a linearized system for analyzing the stability of special points in the following form was revealed: $A = \begin{bmatrix} \gamma_1 \cdot \rho \cdot (d_1 - 2\beta_1^* - \beta_2^*) & -\rho \cdot \gamma_1 \cdot \beta_1^* \\ -\rho \cdot \gamma_2 \cdot \beta_2^* & \gamma_2 \cdot \rho \cdot (d_2 - \beta_1^* - 2\beta_2^*) \end{bmatrix}$, where is (β_1^*, β_2^*) – coordinates of a special point, and $|A - \lambda \cdot I|$ – characteristic equation.

Estimated the species variation in the 2-dimensional case. The coordinates of a special point – a stable node – were recorded. A third-order dynamical system was defined as follows:

$$\begin{cases} \frac{d\beta_1}{dt} = \gamma_1 \cdot \rho \cdot \beta_1 \cdot (d_1 - \beta_1 - \beta_2 - \beta_3) \\ \frac{d\beta_2}{dt} = \gamma_2 \cdot \rho \cdot \beta_2 \cdot (d_2 - \beta_1 - \beta_2 - \beta_3) \cdot \\ \frac{d\beta_3}{dt} = \gamma_3 \cdot \rho \cdot \beta_3 \cdot (d_3 - \beta_1 - \beta_2 - \beta_3) \end{cases}$$

We considered the matrix of a linearized system for analyzing the stability of special points as follows:

$$A = \begin{bmatrix} \gamma_1 \cdot \rho \cdot \beta_1 \cdot (d_1 - 2\beta^*_1 - \beta^*_2 - \beta^*_3) & -\gamma_1 \cdot \rho \cdot \beta^*_1 & -\gamma_1 \cdot \rho \cdot \beta^*_1 \\ -\gamma_2 \cdot \rho \cdot \beta^*_2 & \gamma_2 \cdot \rho \cdot (d_2 - \beta^*_1 - 2\beta^*_2 - \beta^*_3) & -\gamma_2 \cdot \rho \cdot \beta^*_2 \\ -\gamma_3 \cdot \rho \cdot \beta^*_3 & -\gamma_3 \cdot \rho \cdot \beta^*_3 & \gamma_3 \cdot \rho \cdot (d_3 - \beta^*_1 - \beta^*_2 - 2\beta^*_3) \end{bmatrix},$$

where is $(\beta^*_1, \beta^*_2, \beta^*_3)$ – coordinates of a special point, and $|A - \lambda \cdot I|$ – characteristic equation. Next, the species variation was estimated in the 3-dimensional case. The coordinates of a special point – a stable node – were recorded.

Evaluation of competitive interactions of enterprises of different levels of adaptation to market conditions revealed the stability of special points. Variations of cooperative and competitive strategies of agricultural enterprises in the process of adaptation neutralize the manifestations of the principle of competitive exclusion. Strategies of cooperation or containment can be played out in different situations of dynamic change by means of modeling. But there is no single universal model of harmonization of state and market regulatory mechanisms, which would take into account all the features of the development of the adaptation of the economic mechanism of the functioning of agrarian business entities to the conditions of the Ukrainian market.

The processes of hyper-, macro-, meso-, micro- and nano-interactions are so complex that it is still difficult to create such an integrative model. The main difficulty in the development of the model is revealed at the level of meso relations and network structures. The leading center of gravity when using the method of cell networks with

indirect interaction for agricultural business entities as economic agents is in the interaction of the adaptive mechanisms of market agents and state regulation.

In essence, the interaction of adaptation mechanisms with market conditions and the state are parameters of order in the system. It is logical to distinguish the following among the properties of agrarian entrepreneurship entities as economic agents in market conditions: 1) reflexivity as the ability to productively perceive, analyze and transform the structures of intellectual and personal adaptation; 2) normativity as the ability of functional structures, mechanisms and forms of organization to respond to environmental influences; 3) adaptability as the ability to reflect one's situational state (change behavior without changing the organization); 4) adaptability as the ability to survive (change the structural and functional organization) in changing environmental conditions; 5) adaptive stability as the ability to maintain a working state; 6) adaptive variability as the ability to transform the state of the functional structure, mechanisms and forms of organization (to transform the structural and functional organization); 7) modification as the ability to change (improve) the state of their functional structures; 8) constructively as the ability to create fundamentally new cost-effective functional structures; 9) morphosity as the ability to improve innovations.

Let's say you're considering merging from n – agricultural service cooperatives that provide homogeneous services. State and market mechanisms for the implementation of services represent a high-quality environment for economic activity. An agricultural service cooperative is a specifically non-profit organization that meets the needs of the members of the cooperative. Each co-operative is distinguished by a set of properties and a supply of two necessary (but not sufficient) types of resources. We will call one of them "share capital" and denote it classically $K_i^{Пd} = K_i^{Па} + K_i^{Пп}, \quad i = 1,...,n$ (passive and active parts of the share capital). This resource includes proportional fixed differences from each unit of service (independent of the net profit of the current period), withheld cooperative payments (depending on the level of net profit of the current period), funds for the costs of providing services, unit fund funds (entrance fees, additional share contributions), funds for advertising and more. The maximum number of services that a co-operative can provide is

$z_{i\ \max}^{d} = l_i^{kn} \cdot K_i^{Пd}$, where is l_i^{kn} – coefficient characterizing the degree of return of share capital. The economic result of the functioning of the cooperative is not the goal of the viability of the system. This is a consequence of the inability to accurately determine the cost of services before the end of the fiscal year.

If the payment of members for the services of the cooperative exceeds their cost, then the members of the cooperative themselves decide the fate of the resulting economic result. Let's denote the cost of services by the value $s_i^d = \frac{1}{l_i^{кn}}$ i agricultural service cooperative. The association of cooperatives, as a second-tier cooperative, has a more profitable economic result. The cooperative association protects and represents the interests of the cooperative movement. The contributions of associate members supplement the amount of the share contributions. The longer the association of cooperatives functions in the market and the more actively the association of cooperatives operates within the chosen rules of the game, the more reliable the supply of another resource, called "image". Let's denote it $\xi^d{}_i$, $i = 1,...,n$. The environment is allocated in cash V, under which the service can be performed. The demand curve reflects the step-by-step information of the environment about the number of services and their price p_i^{*d}. We will not limit ourselves to the concept of "market memory", since the concept of "memory of the market environment" is more informative and capacious in content.– U_i^d, which includes information not only on successful transactions of cooperatives, on the advantages of adaptive forms of functioning, but also on the mechanisms of their state regulation.

Regulatory instruments include: the volume of operations on the open market, the loan rate, the discount rate, the value added tax, restrictions on the provision of services to non-members of the cooperative, the period of return of the share, the guarantee of income for their shares, the right to choose the tenant and more. Let's outline the regulatory instruments R_i^d. At each individual stage of evolutionary adaptation, the agricultural service cooperative offers services to the market

environment. X_i^d by price p_i^{*d}, and $p_i^{*d} \geq \frac{6}{5 \cdot l_i^{kn}}$ (the price must be higher than the cost price including value added tax). If the amount V_i^{sd} spent completely, the market "swallowed" the cheap service, satisfying the demand. If first-tier cooperatives offer a homogeneous service at the same price, it would be preferable to deal with a cooperative that is part of an association or association of cooperatives. For market relations, a cooperative with a high image is chosen. A standard demand curve for cooperative services is constructed in its adaptive state Q_i^d, but already taking into account the receipt of a certain real number of services z_i^{*d}, rendered i cooperative. In the process of providing services z_i^{*d} the value of the share capital varies. When $z_i^{*d} = z_i^d$ (i.e. the actual number of services corresponds to the potential), the amount of share capital can be determined as follows $\Delta K_i^{Пd} = 0{,}7 \cdot \left(\frac{5}{6} \cdot p_i^{*d} - \frac{1}{l_i^{kn}} \right) \cdot v_i^{sd}$. In essence, this is the final economic result of the cooperative at a time t_i^d, equal E_i^d. He remained in the cooperative as a result of cooperative payments E_i^{1d}, accruals on shares E_i^{2d}, to the reserve fund E_i^{4d} and to a mutual fund E_i^{5d}. The size of accruals on shares is determined by the market rate in the capital market E_i^{3d}.

In the event that $z_i^{*d} \lhd z_i^d$, then we can provide two possible options for the situation: 1) if the implementation of the services offered was not in demand for any reason, then the amount of share capital may have a negative connotation, that is, so $\Delta K_i^{Пd} = 0{,}7 \cdot \left(\frac{5}{6} \cdot p_i^{*d} - \frac{1}{l_i^{kn}} \right) \cdot z_i^{*d} - \frac{1}{l_i^{kn}} \cdot \left(v_i^{sd} - z_i^{*d} \right)$; 2) if the demand for the services offered "remains valid", but can be satisfied only after some time (or in the next period), then additional costs (costs of compensation for supply, processing, procurement, storage or downtime) must be provided for the sale of services.

In other words, each operating cooperative takes into account the coefficient of possible additional costs b_i^d. In this real situation, the amount of share capital is equal

to $\Delta K_i^{\Pi d} = 0{,}7 \cdot \left(\frac{5}{6} \cdot p_i^{*d} - \frac{1}{l_i^{kn}} \right) \cdot z_i^{*d} - \frac{1}{b_i} \cdot \left(\nu_i^{sd} - z_i^{*d} \right)$. Passive share capital (the cost of a stock of ready-to-sell services) and the active part of the share capital are clearly distinguished in this way $K_{a_i}^{\Pi d} = K_i^{\Pi d} - \frac{\nu_i^{*d} - z_i^{*d}}{l_i^{kn}}$. It is this amount of capital that is at the disposal of the cooperative in the event that it considers it necessary to offer new services to the market environment.

An agricultural service cooperative (and even more so an association of enterprises of this type) not only meets the needs (or provides services). The polymorphic structure of adaptation brings significant diversity to the conduct of business. In the zone of special relevance synchronously there is a need to implement a forecast assessment in the analysis of stimulation of credit, investment and innovation attractiveness H_i^{*d}. The effectiveness of these three aspects increases l_i^{kn}. In addition, the associated activity of the cooperative involves additional investments of share capital, conducive to further growth of the image ξ_i^d.

With that said, each stage d the evolutionary adaptation of an existing agricultural service cooperative has distinctive features or characteristics of the state of the economic agent, which are formalized in this way:

$$\left\{ \begin{array}{cccccc} X_i^d & t_i^d & E_i^d & l_i^{k\pi} & \beta_i^d & s_i^d \\ Y_i^d & \xi_i^d & E_i^{1d} & l_i^{*d} & PR_i^{\max} & z_i^d \\ D_i^d & R_i^d & E_i^{2d} & l_i^{1*d} & \tau_i^d & z_i^{*d} \\ L_i^d & Y_i^{*d} & E_i^{3d} & l_i^{2*d} & \tau_i^{*d} & z_i^{**d} \\ H_i^d & A_i^d & E_i^{4d} & \gamma_i^d & (1-\tau)_i^d & p_i^{*d} \\ M_i^d & A_i^{\varphi d} & E_i^{5d} & n_i^d & [\tau_1;1]_i^d & p_i^{**d} \\ V_i^{sd} & EF_i^d & E_i^{*d} & n_i^{*d} & \pi_i^{nd} & p_i^{1d} \\ U_i^d & K_i^{\pi d} & H_i^{*d} & I_i^{od} & \dot{X}_i^d & p_i^{2d} \\ Q_i^d & K_{\alpha i}^{\pi d} & B_i^d & I_i^{1d} & \sigma & p_i^{3d} \\ C_i^d & f(\tau) & F_i^d & K_{\nu i}^{\pi d} & b_i^d & q_i^d \end{array} \right\}$$

where is X_i^d – the relative market share of the cooperative in the market environment; Y_i^d – the real market share of the cooperative in the market environment;

D_i^d – the potential market share of the cooperative in the market environment; L_i^d – the ability to meet the needs of one's own market niche (the minimum required final economic result); H_i^d – the capacity of its own market niche (the maximum desired final economic result); M_i^d – the total amount of money in the market environment; V_i^{sd} – the amount of cash available in the market environment under which the service is performed; U_i^d – memory of the market environment; Q_i^d – the standard demand curve for the services of the cooperative in its adaptive state; C_i^d – the economic growth rate of the cooperative (the duration of the production cycle); t_i^d – time of spatial organization in the cycle; ξ_i^d – the image of the cooperative in the market environment; R_i^d – regulatory instruments of the state and the market; Y_i^{*d} – real aggregate income in the country; A_i^d – structural-functional organization in the space of adaptations (adaptation-diagnosis, adaptation-modification, adaptation-construct, adaptation-morphosis); $A_i^{\varphi d}$ – the effectiveness of the mechanism of nano-adaptation of commodity producers (members of the cooperative); EF_i^d – economic efficiency of activity; $K_i^{\pi d}$ – passive part of the share capital; $K_{\alpha i}^{\pi d}$ – active part of the share capital; $f(\tau)$ – the density of the distribution of share capital; E_i^d – the final economic result of the cooperative at a time t; E_i^{1d} – cooperative payments distributed at the end of the year depending on the final economic result; E_i^{2d} – accruals on shares ($\neq$ dividends) paid at the end of the financial year, depending on the final economic result (up to 20%); E_i^{3d} – the market rate in the capital market, which determines the amount of accruals on shares; E_i^{4d} – the reserve fund formed at the end of the year according to the economic result; E_i^{5d} – a mutual fund formed at the end of the year according to the economic result and by solving the total fees of the members of the cooperative; E_i^{*d} – the final economic result of the cooperative for the implementation of the

investment project; H_i^{*d} – credit, investment and innovative attractiveness of the cooperative; B_i^d – the relationship of the cooperative with the creditor (bank, society, union, etc.); F_i^d – fixed cost of the bank in the loan process (costs, amount of additional investments); $l_i^{k\pi}$ – a coefficient characterizing the degree of return on share capital; l_i^{*d} – proportionality of share contributions of members of the cooperative; l_i^{1*d} – proportionality of the mandatory and additional share contribution; l_i^{2*d} – the share of contributions from associate members of the cooperative; γ_i^d – coefficient of competitive and cooperative interactions; n_i^d – the number of banks in the market environment; n_i^{*d} – optimality of adaptive relations with the bank; I_i^{od} – primary distribution of share capital or investment price at the beginning of the implementation of the investment project; I_i^{1d} – secondary distribution of the share capital or the investment price in the process of implementing the investment project; $K_{\nu i}^{\pi d}$ – share of capital from the cooperative for the bank; $K_i^{\pi d} \times E_i^{*d} = \beta_i^d$ – bank payment for creditors at the time t, when the implemented investment project begins to bring a real economic result; $\frac{\beta_i^d}{I_i^{od} + n_i^d \cdot F_i^d + I_i^{1d}} = PR_i^{max}$ – the maximum interest set by the bank for the cooperative as a borrower; τ_i^d – the probability of obtaining the final economic result; $\frac{I_i^{1d}}{\beta_i^d} \geq \tau_i^{*d}$ – the probability of return of investments to the cooperative in the secondary distribution of capital by the bank (the probability of successful implementation of the investment project by the cooperative); $(1-\tau)_i^d$ – the probability of obtaining a zero final economic result; $[\tau_1;1]_i^d$ – the probability of obtaining an economic result at an intermediate point in time $t = 1(\tau_1 > 0)$; π_i^{nd} – the value of the expected economic result for the cooperative at the initial time of the implementation of the investment project $t = 0$; $\dot{X}_i^d$ – the relative market share of the cooperative in

the environment after the introduction of innovative technology into the production process; σ – constant elasticity of substitution between the two types of services; b_i^d – coefficient of possible additional costs; s_i^d – cost of services of the cooperative; z_i^d – the potential number of co-operative services in a market environment; z_i^{*d} – the real number of services of the cooperative in the market environment; z_i^{**d} – the relative number of services of the cooperative in the market environment; p_i^{*d} – price set by the co-operative at a time t; $\frac{p_i^{*d}}{q_i^d} = p_i^{**d}$ – the market price of services in the environment; q_i^d – constant elasticity of substitution index for the aggregate price level; p_i^{1d} – the price per service predicted by the co-operative at the beginning of the season; p_i^{2d} – cooperative payments to members of the cooperative at the end of the financial year; p_i^{3d} – the final price for the service, established by the cooperative and dependent on the results of the joint activities of the members of the cooperative.

"Rules of the game in the market environment" determine the trajectory of movement and the zone of the proximal development of the agricultural service cooperative in the space of states at the meso- and micro-level, and the systemic active movement of the cooperator in the temporal, spatial, functional, stochastic, effective and synthetic connections of the nano-economy. These "rules of the game in the market environment" form a system (framework) of interaction between agricultural service cooperatives. The construction of this framework represents the main difficulty in building a model. It is logical to present the main properties of agricultural service cooperatives as economic agents as follows.

1. Having chosen the "rules of the market game", the agricultural service cooperative sufficiently effectively and expediently perceives and analyzes information on the state of market conditions and the effectiveness of state regulation mechanisms; correlates it with its adaptation parameters and, as a result, transforms the nano-structures of the adaptation process.

2. Since the cooperator in the process of evolutionary adaptation constantly monitors the state of market conditions and the positions of the state, any changes synchronously and adequately affect the adjustment of the selected rule; the functional structure, economic mechanism and form of organization can respond to the effects of the environment within acceptable limits (adapted norm); if this is not enough, the cooperator goes into the mode of implementing a set of response modifications, that is, it operates in the zone of the adaptive norm.

3. Co-operators are able to independently diagnose their financial and economic condition without the intervention of other economic agents.

4. In the event that the change of behavior in the market is not of fundamental importance, then in order to survive the enterprise, the cooperator changes the structural and functional organization of its cooperative adequately to the new conditions and requirements of the environment.

5. The processes of adapted evolution of the transformational economy are confirmed by the ability of the cooperative to maintain a working state.

6. At each stage of evolutionary adaptation, cooperatives as economic agents solve a nine-circuit optimization task: maximizing the volume of services (capturing the market), maximizing working capital, minimizing cooperative payments, maximizing the share fund, minimizing dividends on share capital, ensuring the return of the share contribution, ensuring adaptive relations between the bank and the agricultural service cooperative, minimizing risk (the probability of bankruptcy of the cooperative or withdrawal of a member from the cooperative, or reducing the level of use of the share), providing a flexible pricing mechanism for the services provided; co-operators solve a multi-criteria optimization problem; in this case, the decision process depends on the choice of "rules of the market game", specific adaptation parameters (and alternatives to the Paret set for analysts).

7. The requirements of the market environment and the need for credit, investment and innovation attractiveness of the agricultural service cooperative actualize the issues of improving the state of its functional structures; as a result of

modernization, the agricultural service cooperative changes its characteristics (share capital return coefficient, advertising funds, image growth, etc.).

8. Powerful competition in market conditions creates favorable conditions not only for improving its functional structure, but also for creating a fundamentally new cost-effective management structure.

9. The polymorphic structure of the adaptation of the cooperative assumes, at a minimum, the manifestation of the ability to improve the innovations of the adaptation of the economic mechanism of functioning and is accompanied by local manifestations of intraspecific modifications.

Thus, in the course of the study, it has been established that the use of means of modeling the mechanisms of market interaction mechanisms contributes to an adequate search for ways to improve the adaptation of the economic mechanism of functioning of agrarian business entities to market conditions. Increasing competitive and cooperative interactions of agricultural business entities increases their adaptive status in the environment of functioning. Prospects for further scientific research in this direction are associated with the construction of a system for modeling the processes of adaptation of the economic mechanism of the functioning of agricultural enterprises to market conditions and the deepening of their own classification of methods of adaptive processes.